Citation:

Luber P. Cross-contamination vs. undercooking of poultry meat or eggs: Which risks need to be managed first? *Int J Food Microbiol.* 2009 Aug 31; 134(1-2): 21-28.

PubMed ID: 19272666

Study Design:

Systematic - Comprehensive Risk Analyses

Class:

M - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

NEUTRAL: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To use a systematic review to elucidate whether cross-contamination events or undercooking are a greater risk for human illness from zoonotic pathogens associated with poultry, in order to prioritize the message given to the consumer.

Inclusion Criteria:

- Studies with data considering the location of *Campylobacter* spp. or *Salmonella* spp. on the surface of or inside of poultry meat and eggs
- Studies found using the key words “Salmonella” and “Campylobacter”, each in combination with the terms “poultry”, “chicken”, “turkey”, and “egg” combined with “quantitative”, “cross-contamination”, and “undercooking”
- Studies on risk assessment that were found by combining the terms “risk” and “assessment” with either “Salmonella” or “Campylobacter”
- Studies on risk communication matters that were found using the terms “risk” and “communication”, in combination with “Salmonella”, “Campylobacter”, “poultry”, “egg”, “undercooking”, and “cross-contamination”, respectively.

Exclusion Criteria:

- Studies presenting quantitative results for samples of (e.g., 25g without detailed information on the nature of the sample taken or on the procedure that has been used for sampling); it is not clear how much of the surface area was included during sampling
- Papers with data referring to internal contamination were checked for the application of methods, such as surface sterilization and sterilizing steps for the sampling equipment, as bacteria originating from the surface may contaminate an internal meat sample or the egg contents if no measures are taken to prevent this from happening.

Description of Study Protocol:

Recruitment

- Studies found during a literature research performed from May to June 2008 using the ISI Web of Knowledge databases by The Thomson Corporation
- 16 quantitative and qualitative studies were included on *Salmonella* spp. and *Campylobacter* spp. in chicken, turkey and duck meat that specifically address the location of the bacteria
- Nine studies were included on the contamination of chicken hens' table eggs with *Salmonella* spp. and *Campylobacter* spp. that specifically address the location of the bacteria
- Eight studies evaluated risk assessments regarding the assessment of the relative risk of cross-contamination and undercooking (one primary abstracted by NEL)
- Six studies were included on the subject of communication about food safety risks to consumers specifically addressing consumer handling during preparation of poultry meat or eggs (one review, one primary abstracted by NEL).

Design

Systematic review and comprehensive risk analyses.

Statistical Analysis

Study results were evaluated and compared as follows:

- For the 16 quantitative and qualitative studies on *Salmonella* spp. and *Campylobacter* spp. in chicken, turkey and duck meat that specifically address the location of the bacteria:
    - Pathogen
    - Prevalence and number of bacteria on the surface or inside of the meat (samples included in the study)
- For the nine studies on the contamination of chicken hens' table eggs with *Salmonella* spp. and *Campylobacter* spp. that specifically address the location of the bacteria:
    - Pathogen
    - Prevalence of bacteria on the surface or inside of shell eggs (samples included in the study)
- Eight studies evaluating risk assessments regarding the assessment of the relative risk of cross-contamination and undercooking:
    - Campylobacteriosis cases
    - Degree of bacterial contamination of meat
    - Exposure to *Campylobacter* spp. and *Salmonella* spp. to subjects
- For the six studies on the subject of communication about food safety risks to consumers specifically addressing consumer handling during preparation of poultry meat or eggs:
    - Observation
    - Recommendation for consumer information.

Data Collection Summary:

For eight studies evaluating risk assessments regarding the assessment of the relative risk (RR) of cross-contamination and undercooking:

Dependent Variables

- Campylobacteriosis cases
- Degree of bacterial contamination of meat
- Exposure to *Campylobacter* spp. and *Salmonella* spp.

Independent Variables

- Different exposure pathways leading to contamination of meat (cross-contamination events, inadequate hand washing, not cleaning the kitchen environment or undercooking)
- Levels of bacteria on surface or inside meat or carcasses
- Age and gender
- Consumption patterns of consumers
- Relationship between people preparing and ingesting food.

Description of Actual Data Sample:

- *Initial N:* Total number of studies identified from the search was not reported
- *Attrition (final N):*
  - 16 quantitative and qualitative studies included on *Salmonella* spp. and *Campylobacter* spp. in chicken, turkey and duck meat that specifically address the location of the bacteria
  - Nine studies included on the contamination of chicken hens' table eggs with *Salmonella* spp. and *Campylobacter* spp. that specifically address the location of the bacteria
  - Eight studies evaluating risk assessments regarding the assessment of the RR of cross-contamination and undercooking
  - Six studies included on the subject of communication about food safety risks to consumers specifically addressing consumer handling during preparation of poultry meat or eggs
- *Location:* Location of these studies vary, but are not specifically reported in article.

Summary of Results:

Key Findings

- Location of bacterial pathogens:
  - Poultry meat:
    - Average prevalence of *Salmonella* spp. on the surface of poultry meat products is 22.6% (2,936 samples, nine datasets) and the prevalence of *Salmonella* spp. on the surface of poultry meat is about six times higher that the prevalence of this pathogen inside of the meat
    - Average prevalence of *Campylobacter* spp. on the surface of poultry meat was 62.3% (3,235 samples, 14 datasets) and, on average, the prevalence of external contamination of poultry meat with *Campylobacter* spp. is six times higher than a contamination deeper in the meat
  - Shell eggs:
    - In eight studies with a total of 14,343 pooled samples, surface prevalence of *Salmonella* spp. ranged form 0.04% to 9.0% positives. Especially high prevalence rates were found in studies from India and Trinidad and Tobago.
    - Two studies from the US showed a prevalence of 0.5% and 0.6% of

Campylobacter spp.-positive egg shells
        - In two studies, prevalence of *Salmonella* spp. on the egg surfaces was almost twice as high as the prevalence of *Campylobacter* spp.
- Evaluation of risk assessments regarding the assessment of the relative risk of cross-contamination and undercooking:
    - Model simulations revealed that 74% of campylobacteriosis cases were caused by cross-contamination events involving *Campylobacter* spp. from the surface of chicken meat during the preparation of meals in private homes, but only 3% of cases could be attributed to consumption of undercooked products; in 23% of cases, more than one exposure pathway (e.g., inadequate hand washing, not cleaning the kitchen environment or undercooking) was involved in increasing the probability of illness
    - An elimination of the poultry meat products that are highly contaminated, especially on the surface of chicken meat, will have a great effect in lowering the campylobacteriosis risk in risk assessment on duck breast meat
    - Campylobacteriosis risk originating from consumers' exposure via cross-contamination is multitudes higher than the risk resulting from consumption of pink duck breasts
    - A reduction of numbers of *Salmonella* spp. on the surface of chicken carcasses and even a small reduction in the frequency of undercooking and the magnitude of the undercooking event during preparation of meals result in a marked reduction of the expected risk of illness per serving
    - The probability of ingesting a risk meal was highest for young males aged 18 to 29 years and lowest for the elderly above 60 years of age; simulated results show that the probability of ingesting a chicken risk meal at home does not only depend on the hygiene practices of the persons preparing the food, but also on the consumption patterns of consumers and the relationship between people preparing and ingesting food.

Other Findings

Risk communications strategies:

- Preliminary analysis of current risk communication strategies showed that they mainly focus on getting consumers to avoid undercooking of poultry meat and consumption of dishes with raw eggs, and less on information that focuses on avoiding cross-contamination
- Analysis of risk communication strategies that specifically address consumer handling during preparation of poultry or eggs revealed that communication and education activities will not necessarily result in a change of consumers' behavior.

Author Conclusion:

- The evaluation of risk assessment studies showed that in the case of *Campylobacter* spp. and poultry meat, cross-contamination is considered the dominant route of exposure
- Cross-contamination events from activities such as use of the same cutting board for chicken meat and salad without intermediate cleaning or spreading of pathogens via the kitchen environment, seem to be of greater importance than the risk associated with undercooking of poultry meat or eggs
- In order to reduce consumers' exposure to pathogens such as *Salmonella* spp. and *Campylobacter* spp. in poultry meat and eggs during preparation of these foods, management activities should focus on cross-contamination risks

- More risk assessments addressing exposure through this exposure pathway and research on cross-contamination events would be helpful to support future risk management decisions.

Reviewer Comments:

Study quality and validity not assessed in this review.

Research Design and Implementation Criteria Checklist: Review Articles

Relevance Questions		
1.	Will the answer if true, have a direct bearing on the health of patients?	Yes
2.	Is the outcome or topic something that patients/clients/population groups would care about?	Yes
3.	Is the problem addressed in the review one that is relevant to nutrition or dietetics practice?	Yes
4.	Will the information, if true, require a change in practice?	Yes

Validity Questions		
1.	Was the question for the review clearly focused and appropriate?	Yes
2.	Was the search strategy used to locate relevant studies comprehensive? Were the databases searched and the search termsused described?	Yes
3.	Were explicit methods used to select studies to include in the review? Were inclusion/exclusion criteria specified and appropriate? Were selection methods unbiased?	Yes
4.	Was there an appraisal of the quality and validity of studies included in the review? Were appraisal methods specified, appropriate, and reproducible?	No
5.	Were specific treatments/interventions/exposures described? Were treatments similar enough to be combined?	???
6.	Was the outcome of interest clearly indicated? Were other potential harms and benefits considered?	Yes
7.	Were processes for data abstraction, synthesis, and analysis described? Were they applied consistently across studies and groups? Was there appropriate use of qualitative and/or quantitative synthesis? Was variation in findings among studies analyzed? Were heterogeneity issued considered? If data from studies were aggregated for meta-analysis, was the procedure described?	Yes
8.	Are the results clearly presented in narrative and/or quantitative terms? If summary statistics are used, are levels of significance and/or confidence intervals included?	Yes
9.	Are conclusions supported by results with biases and limitations taken into consideration? Are limitations of the review identified and discussed?	Yes

10. Was bias due to the review's funding or sponsorship unlikely? ???